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PG&E Area
Conceptual Transmission Plan for Importing Tehachapi Generation

Based on the

Tehachapi Collaborative Study Group Report

Filed March 16, 2005 at the CPUC

California Energy Commission Workshop

Sacramento, California

May 19, 2005

Chifong Thomas

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Tehachapi Collaborative Study

- CPUC Decision 04-06-010 => the Tehachapi Collaborative Study Group (TCSG)
  - develop conceptual transmission plan to connect 4,000 MW of wind generation in Tehachapi Area
- SCE filed Report on March 16, 2005
  - Conceptual transmission plans only
  - Recommends further studies
- This discussion is on technical aspects and on PG&E Area only

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Topics

- Conceptual Transmission Plan Study Limitations
- Major Assumptions
- General Study Methodology
- Power Flow Study Results Summary
- Some Observations
- PG&E Area Conceptual Transmission Alternatives
- Further Studies

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Conceptual Transmission Study Limitations

- Based only on steady state power flow studies to evaluate compliance with NERC/WECC Planning Standards.
- Did not perform the following required analyses:
  - voltage stability
  - dynamic transient stability
  - operation evaluation (spinning reserve, intermittent resources, generation ramping)
  - preliminary engineering evaluation
  - preliminary environmental review
  - Economic evaluation, and others
- Not all potential problems or mitigation measures have been identified

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Major Assumptions

- Assume 4,000 MW at Tehachapi Area
- Assume all 4,000 MW will meet least cost – best fit selection criteria
- Assume 2,000 MW will flow to PG&E load centers
- Assume system conditions studied identical to:
  - CAISO Controlled-Grid Study
  - System Impact Studies

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Power Flow Study Base Cases

Reviewed and Approved by CAISO and Stakeholders

- **2009 summer peak base case**
  - Start with the CAISO 2004 Controlled-Grid Study base case
  - Updated with 1-in-10 year adverse weather load forecast for the Greater Fresno Area.
- **2009 summer off-peak base case**
  - Based on the PG&E's 2004 Electric Transmission Assessment Study base case for Area 6 (Yosemite, Fresno and Kern Divisions).

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General Study Methodology

- Identify all potential problems
  - Common transmission planning practices
    => displace generation outside the immediate study area
  - Reason for Renewable resources
    => displace generation from older, more polluting generators
  - Run selected outage simulations
- Develop alternative solutions
- Evaluate and refine solutions
- Recommendation

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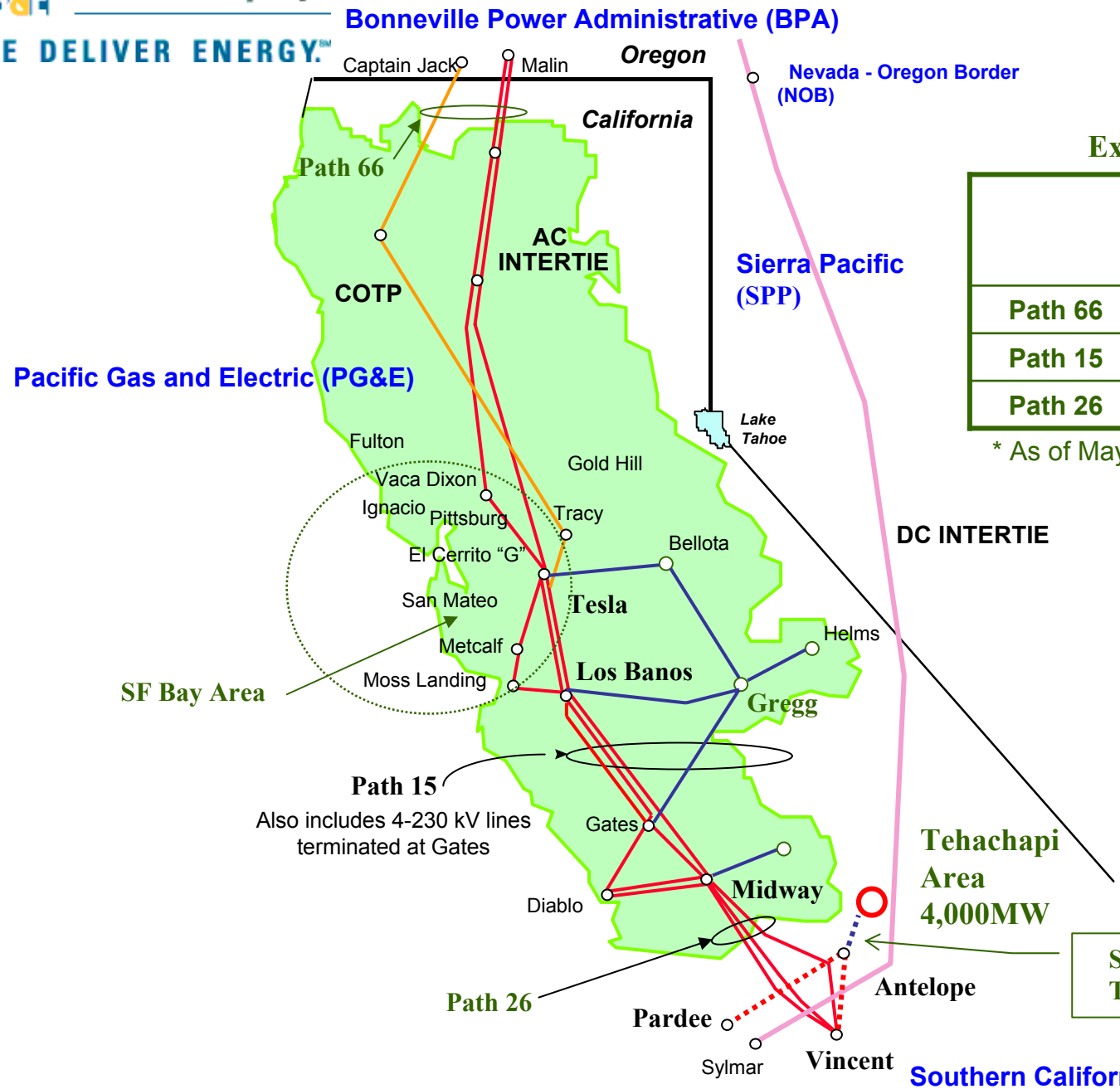
Simplified Existing Transmission System Expected by 2009



Existing Path Ratings

	North-to-South (MW)	South-to-North (MW)
Path 66	4,800	3,675
Path 15	3,265	5,400
Path 26	3,700*	3,000

* As of May 2, 2005

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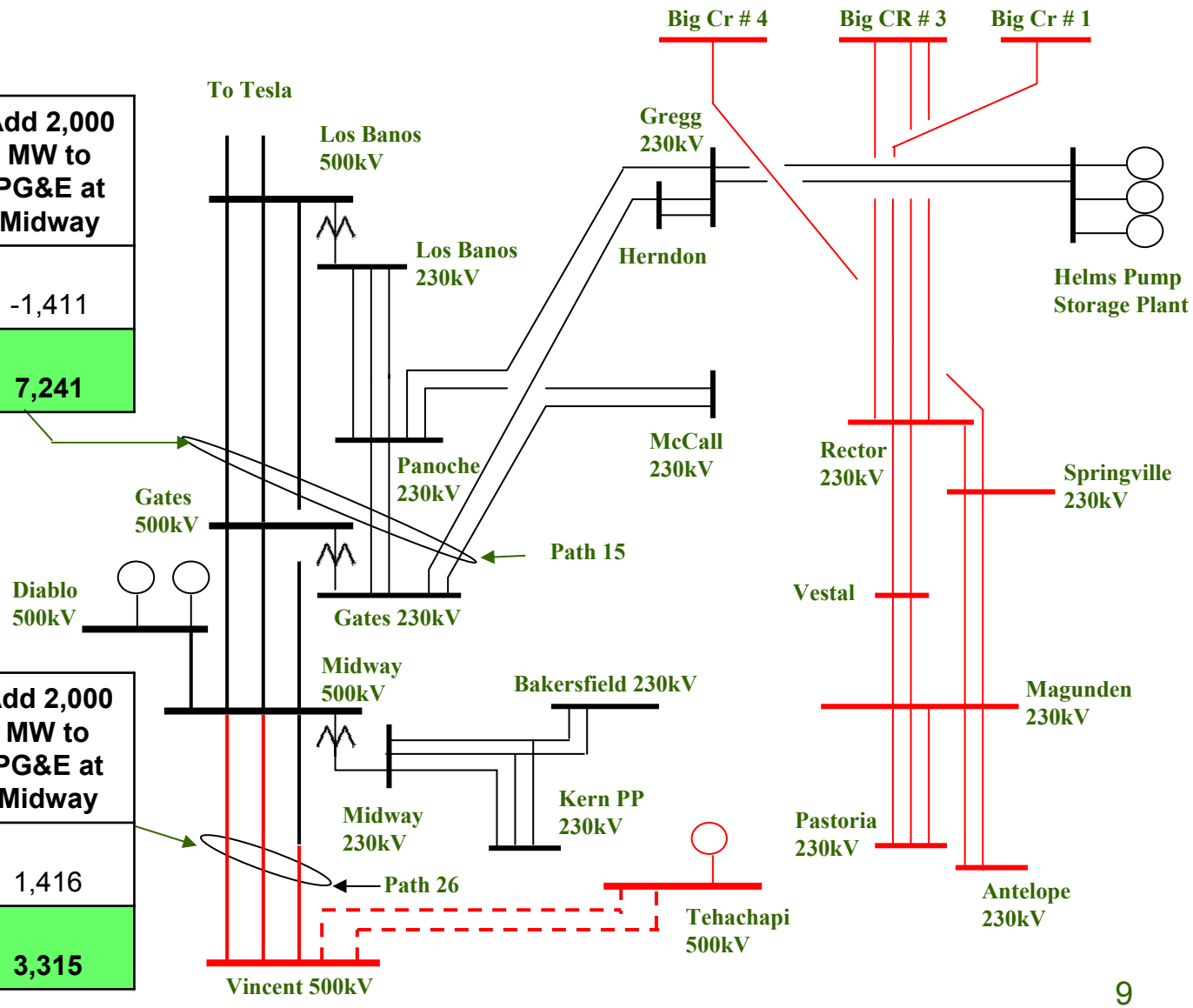
Simplified Existing System Expected by 2009

Path 15 Power Flow

System Conditions	Existing Transfer	Add 2,000 MW to PG&E at Midway
On-Peak north to south	558	-1,411
Off-Peak south to north	5,399	**7,241**

Path 26 Power Flow

System Conditions	Existing Transfer	Add 2,000 MW to PG&E at Midway
On-Peak north to south	3,403	1,416
Off-Peak south to north	1,325	**3,315**



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PG&E Area Study Summary

2009 Summer Peak Base Case

Descriptions	Existing Transfer	Importing 2,000 MW at Midway w/o upgrade
Path 66 Flow (north to south)	4,800	4,518
Path 15 Flow (north to south)	*558*	*-1,411*
Path 26 Flow (north to south)	*3,403*	*1,416*
PDCI Flow (north to south)	3,094	3,090
PG&E Area Load plus Losses	27,480	27,467
PG&E Area Generation	26,039	24,317
Fresno Area Load plus Losses	3,088	3,083
Helms PSP Generation	1,200	1,200
Fresno Transmission Imports	635	629
Imports from Tehachapi Generation	0	2,000
Generation Reduction in the Bay Area	0	1,700

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PG&E Area Study Summary

2009 Summer Off-Peak Base Case

Descriptions	Existing Transfer	Import 2,000 MW at Midway w/o upgrade
Path 66 Flow (south to north)	**3,670**	**3,526**
Path 15 Flow (south to north)	***5,399***	***7,241***
Path 26 Flow (south to north)	***1,325***	***3,315***
PDCI Flow (south to north)	**1,848**	**1,848**
PG&E Area Load plus Losses	**13,225**	**13,397**
PG&E Area Generation	**15,546**	**13,582**
Fresno Area Load plus Losses	**1,545**	**1,549**
Helms PSP Generation*	**- 620**	**- 620**
Fresno Transmission Imports	**2,025**	**2,029**
Imports from Tehachapi Generation	**0**	**2,000**
Gen Reduction in Bay Area	**0**	**2,000**

* Negative values indicate pumping mode.

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PG&E Area Study Summary

2009 Summer Off-peak Base Case without Contingencies

Transmission Facilities	SN Rating	Existing Transfer		Import 2,000 MW at Midway w/o upgrade	
	(Amps)	(Amps)	(%)	(Amps)	(%)
Gates - Midway #1 500 kV line	2230	2107.1	94.5	3212	*144.0*
Los Banos - Midway 500 kV line	2230	1864.1	83.6	2787	*125.0*
Los Banos - Gates #1 500kV line	2230	1712.9	76.8	2516	*112.8*
Los Banos - Gates #3 500kV line	2230	843.9	37.8	1236	55.4
Gates - Panoche #1 230kV line	742	581.4	78.4	824	*111.0*
Gates - Panoche #2 230kV line	742	581.4	78.4	824	*111.0*
McCall - Henrietta tap2 230kV line	825	868.3	*105.2*	997	*120.9*
Gates - Henrietta tap1 230kV line	1600	1482.6	92.7	1690	*105.6*
Gates - Midway 230kV line	742	622.1	83.8	799	*107.7*
Los Banos - Westley 230 kV line	1484	1101.0	74.2	1480	99.7

Note: Because this is a conceptual study, potential problems in the 115 kV and 69 kV systems were not shown.

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Some Observations

- Summer Peak (w/ 3400MW N – S flow on Path 26)
  - No normal or emergency overload for importing 2000 MW of Tehachapi generation.
- Summer Off-peak (w/ 5400MW S – N flow on Path 15)
  - No spare transmission capacity for importing new generation in SP15.
  - Import additional generation from SP15 (including Tehachapi) >> Normal and emergency overloads
    - Limitation - the existing Path 15 south-to-north transfer capability of 5400MW.
  - Less than half of the **existing** Path 26 south-to-north transfer capability (3000MW) were used for importing from SCE because of the Path 15 limitation.

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Status Quo – Not Recommended

- Tehachapi Gen displaces existing Contracts
  - Consistent with FERC Open Access?
  - Impacts of the transmitting the displaced power transfers related to existing contracts?
- Tehachapi Gen displaces Midway Area Gen
  - Consistent with FERC Open Access?
  - Midway Area Gen must be on line as RAS to support Path 15 Rating.
    - Lower Midway Gen => Lower Path 15 Rating
  - Replace Midway RAS Gen with Tehachapi Gen RAS
    - Less effective due to location
    - Need new type of RAS Controller to estimate intermittent energy
    - Need to place also Regulating Gen (unknown) on RAS

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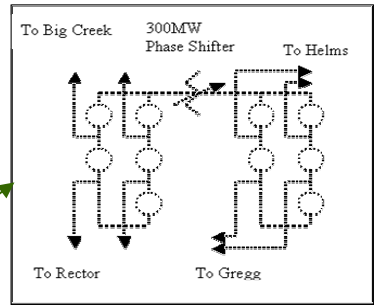
Cost: ~ $50 million (PG&E)
plus ~ $50 million (SCE)



Alt. 2: Fresno 230kV Tie

Big Cr # 4
Big Cr # 3
Big Cr # 1
Gregg 230kV
Herndon
Helms Pump Storage Plant
Los Banos 500kV
Los Banos 230kV
McCall 230kV
Path 15
Panoche 230kV
Rector 230kV
Springville 230kV
Gates 500kV
Gates 230kV
Vestal
Alt 3: Magunden 230kV Tie
Diablo 500kV
Bakersfield 230kV
Magunden 230kV
Midway 500kV
300MW Phase Shifter
Midway 230kV
Path 26
Kern PP 230kV
Pastoria 230kV
Vincent 500kV
Antelope 230kV

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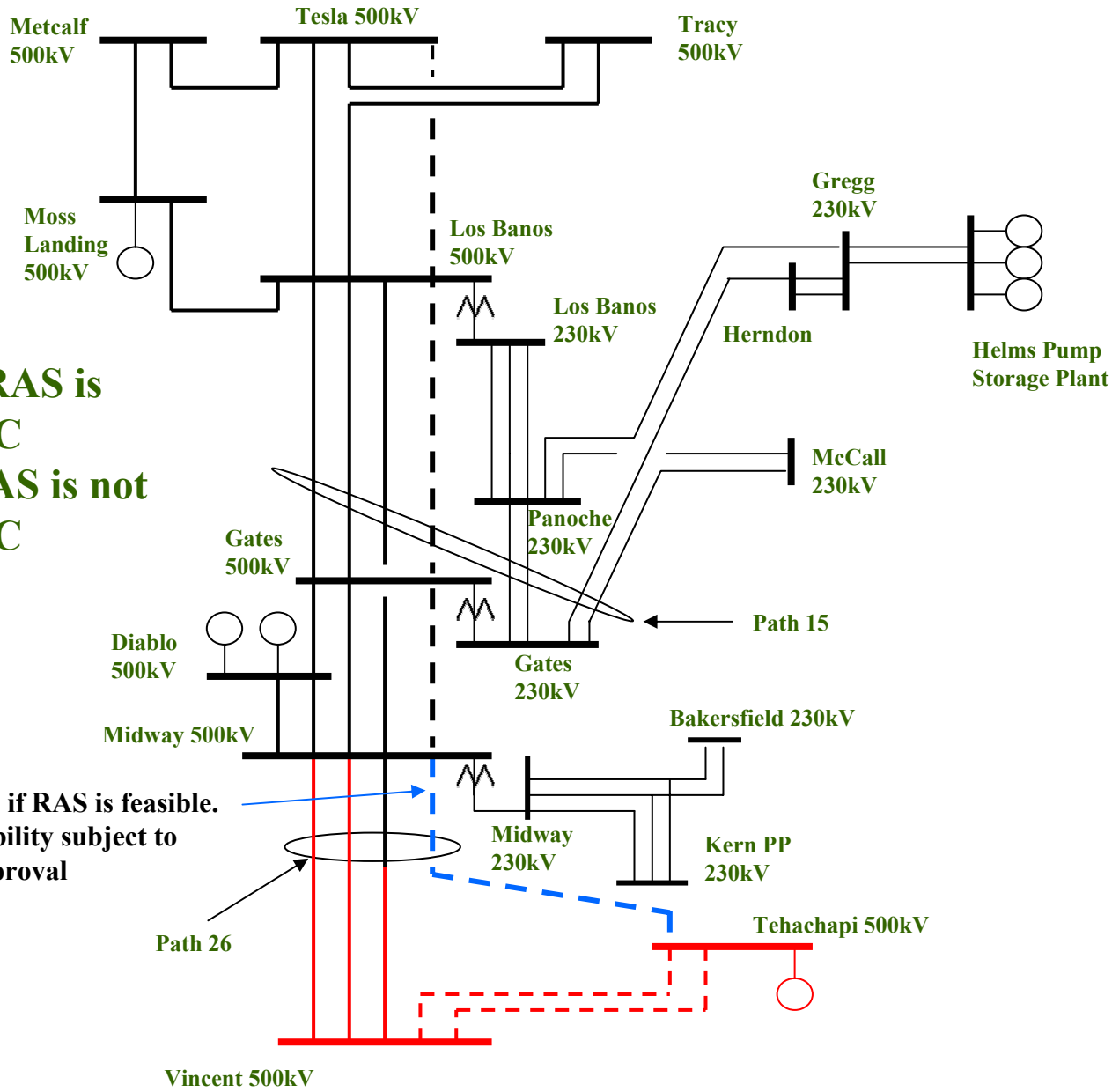
Alt. 4: Tesla-Los Banos-Midway-Tehachapi



PG&E Cost:
~ $718+ million if RAS is approved by WECC
~ $964 million if RAS is not approved by WECC

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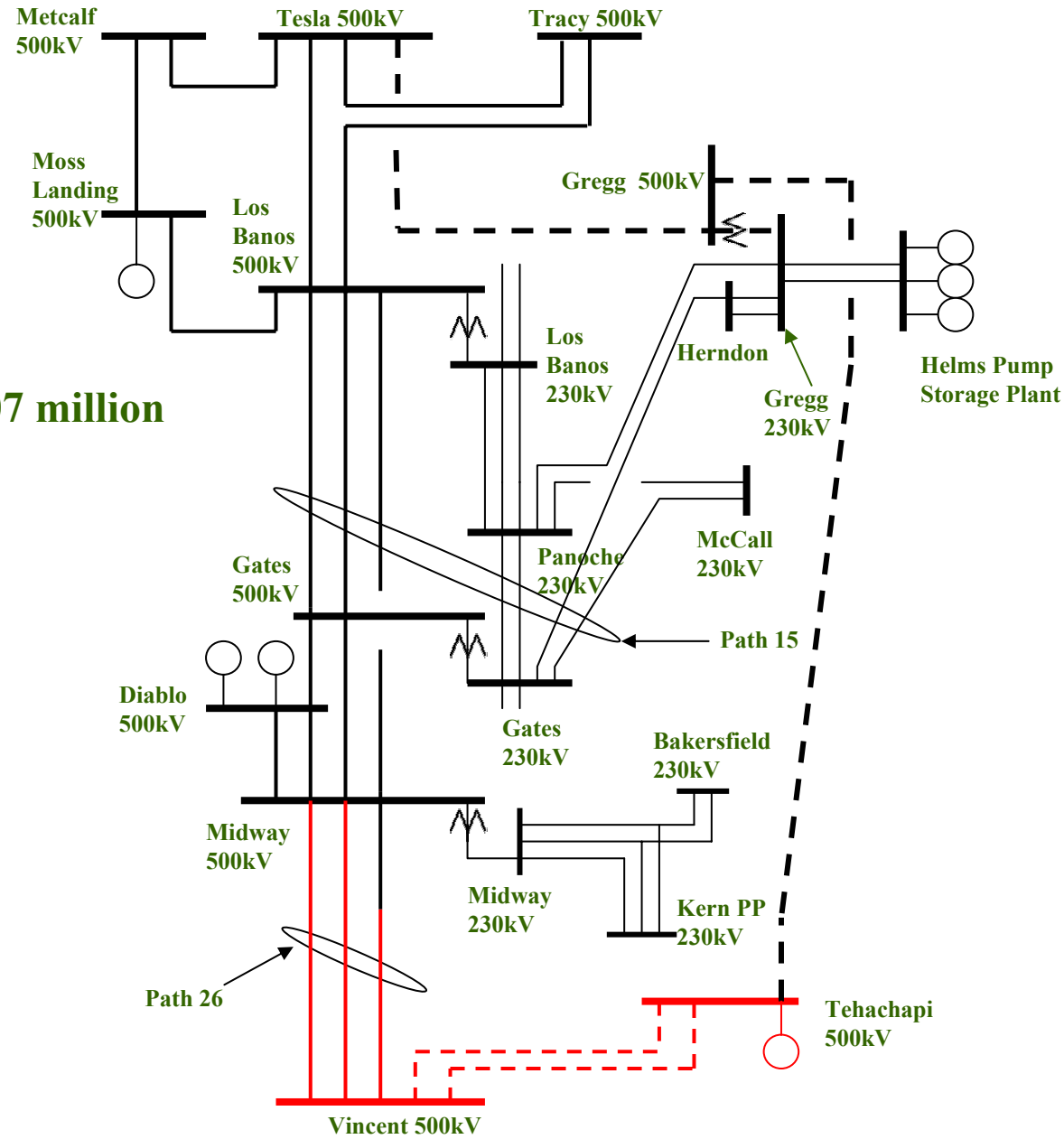
Alt. 5: Tesla-Los Banos-Gregg-Tehachapi

PG&E Cost: ~ $1,007 million



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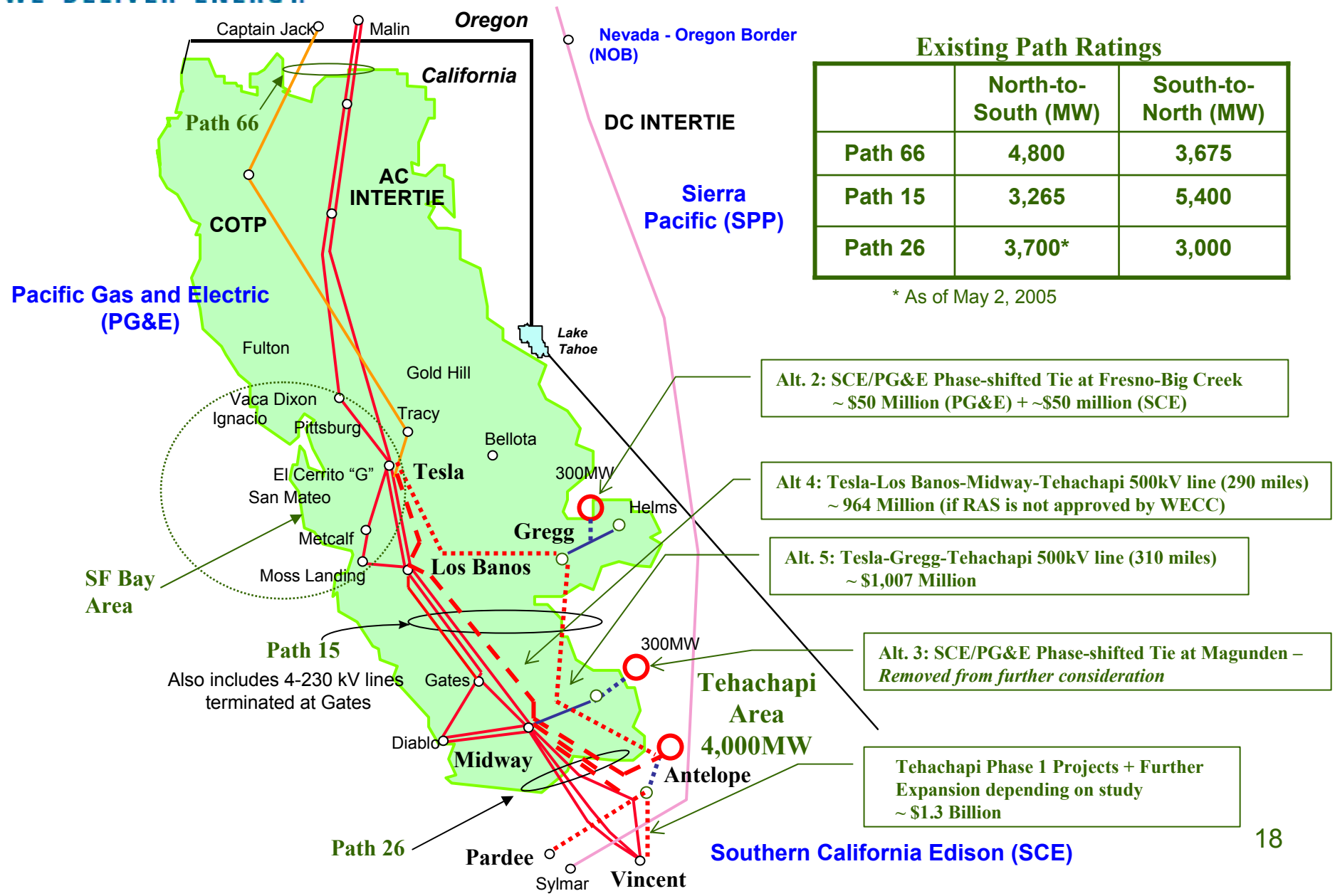
Conceptual Transmission Alternatives for Importing Tehachapi Generation



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* As of May 2, 2005

Alt. 2: SCE/PG&E Phase-shifted Tie at Fresno-Big Creek
~ $50 Million (PG&E) + ~$50 million (SCE)

Alt 4: Tesla-Los Banos-Midway-Tehachapi 500kV line (290 miles)
~ 964 Million (if RAS is not approved by WECC)

Alt. 5: Tesla-Gregg-Tehachapi 500kV line (310 miles)
~ $1,007 Million

Alt. 3: SCE/PG&E Phase-shifted Tie at Magunden –
Removed from further consideration

Tehachapi Phase 1 Projects + Further Expansion depending on study
~ $1.3 Billion

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Conceptual Transmission Alternatives

Import	PG&E Alternative 2	PG&E Alternative 4	PG&E Alternative 5
300 MW	Build a 230kV 300MW phase-shift switching station at Big Creek. **Other Network Upgrades:** None for PG&E, SCE upgrades needed	N/A	N/A
1100 MW	N/A	**Phase A:** Build a new Los Banos – Midway 500kV line with 65% series comp **Other Network Upgrades:** Upgrade Los Banos – Westley 230kV line and Los Banos 500/230 kV transformer.	**Phase A:** Build a new Gregg - Tehachapi 500kV line with 62% series comp and a new Gregg 500kV Substation with one 500/230kV bank. **Other Network Upgrades:** Upgrade Los Banos - Westley 230kV line
1500 MW	N/A	**Phase B:** Same as Phase A, except also building a new Tesla – Los Banos 500kV line. **Other Network Upgrades:** None	**Phase B:** Same as Phase A, except also building a new Tesla - Gregg 500kV line w/o series comp. **Other Network Upgrades:** None
2000 MW	N/A	**Phase C:** Same as Phase B, except also install RAS to trip Tehachapi generation. (RAS subject to WECC approval) **Other Network Upgrades:** None if RAS is approved. However, if the RAS is not approved, then new transmission facilities would be needed.	**Phase C:** Same as Phase B, except installing 62% series comp on the Tesla – Gregg. **Other Network Upgrades:** None

Further Studies

- How would detailed modeling of the Tehachapi Collector System impact stability performance?
- How would Tehachapi Generation impact operations?
- Alternative 2: Fresno – Big Creek 230 kV Tie
  - How much can this tie take?
  - What Transmission Upgrades are needed in SCE and PG&E?
- Alternative 4: Tesla-Los Banos-Midway-Tehachapi
  - Can we use RAS to avoid building Midway-Tehachapi?
- Alternative 5: Tesla-Los Banos-Gregg-Tehachapi
  - If we terminate at Midway, do we need to go all the way to Tehachapi?
- Other technical issues?

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Other Questions

These Transmission Projects are Resource-driven:

- When will the transmission additions for Tehachapi generation be needed?
- What is the renewable generation mix that would constitute least cost-best fit for California?
- Impacts of other transmission/resources being developed in WECC?
  - Frontier Line
  - Northern Lights Project
  - Lines to AZ